branches of science. This is not a complete index of the meteorological contents of all the journals from which it has been compiled; it shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau. Unsigned articles are indicated by a ——

American geographical society. Bulletin. New York. v. 40. September, 1908.

Huntington, Ellsworth. The climate of ancient Palestine. p. 513–522.

Science. New York. New series. v. 28. October 9, 1908.

Shaw, W. N. Address of the president to the mathematical and physical section of the British association for the advancement of science. p. 457–471.

Archives des sciences physiques et naturelles. Genève. Tome 26. 15 September, 1908.

Ramsay, William. Les gaz inertes de l'atmosphére et leur derivation de l'emanation des corps radioactifs. p. 240-262.

Nature. Paris. 36 année. 12 Septembre, 1908.

—— E. Mascart. p. 238–240. [With portrait.]

Revue néphologique. Mons. No. 32. Août 1908.

Leal Mariano. A propos d'un nouvel anémomètre enregistreur. p. 49–50.

Geographische Zeitschrift. Leipzig. 14 Jahrgang. September, 1908.

Mecking, Ludwig. Der heutige Stand der Geographie der Antarktis. II. Das Klima. p. 481–492.

Meteorologische Zeitschrift. Braunschweig. Band 25. September, 1908.

Obermayer, A. von. Zwanzig Jahre meteorologischer Beobachtungen auf dem Ben Nevis. p. 385–396.

Russeltvedt, Nils. Ein neues Haarhygrometer. [Illustrated.] p. 396–400.

Meissner, Otto. Die Luftbewegung in Potsdam (1894 bis 1900). p. 400–409.

—— A. Gockel über den Gehalt der Bodenluft an radioaktiver Emanation. p. 410–412.

Busch, Fr. Eine neue Störung der atmosphärischen Polarisation. p. 412–414.

Sch., E. Schubert, der Wasserhaushalt an der Erdoberfläche. [Review.] p. 415–416.

Heidke, P. Resultate der meteorologischen Beobachtungen zu Kwai (Usambara) in den Jahren 1897 bis 1902. p. 416–418.

—— Meteorologische Beobachtungen im arktischen Nordamerika auf Herschel Island 1905. p. 418–419.

Friesenhof, Gregor. Zur lokalen Entstehung der Zyklonen. p. 419–420.

H[ann], J[ulius]. Stündliche Intensität der Regen zu Batavia und Pasuruan. p. 422.

Maurer, Hans. Regenmengen im Nigergebiet. p. 423–425.

Siegel, Fr. Meteorologisches Observatorium erster Ordnung zu Curityba (Paraná). p. 426–427.

Little, C. Ueber eine Windstille Region in 3,000 bis 4,000 engl. Fuss Seehöhe in der kalten Jahreszeit in der Gegend von Calcutta. p. 427.

Hann, J. Regenfall zu Pernambuco (Recife). [Collected data, 1887–1906.] p. 429.

Physikalische Zeitschrift. Leipzig. 9. Jahrgang. 15 September, 1908.

Kaufmann, W. Leuchtende Wolke. [Includes photograph of sky glow, July 2, 1908]. p. 606–607.

Wetter. Berlin. 25. Jahrgang. September, 1908.

Grundmann, G. Ueber einen einfachen Gewitterregistrator mit dem Verbesserten Schreiberschen Nadelkohärer. [Illustrated.] p. 193–201.

Schulze, Paul. Ludwig Friedrich Kämtz. p. 201–203.

Joester, Karl. Die Föhnerscheinungen im Riesengebirge. p. 203–206.

Becke, L. von der. Die Ergebnisse meteorologischer Beobachtungen auf der Lloyds-Signalstation auf Kap Spartel für das Jahr 1907 in Monats-und Jahresmitteln. p. 209–211.

Freybe, Otto. Ein Vormittag an einer Wetterdienststelle. p. 213–216.

AN ANNOTATED BIBLIOGRAPHY OF EVAPORATION.

By MRS. GRACE J. LIVINGSTON. Dated Washington, D. C., January 8, 1908.

[*Continued from the Monthly Weather Review, June, 1908.*]

1782.

Eason, Alexander.
On the ascent of vapor. (1782.) Mem. lit. phil. soc., 1785, 1:395–405.

1786.

Rosenthal, Gottfried Erich.
Ueber P. Cotte's Versuch die Stärke der Ausdünstungs im Rücksicht auf die Höhe und den Durchmesser der Gefässe die zum Maasse gebraucht werden. Mag. neu. Phys., 1786, 1 (pt. 4):142–54.

It is claimed that the law of differences, for evaporation from different vessels, which Cotte (1781) failed to find, is as follows: (1) dishes of like height and surface give like evaporation in the same time and place; (2) dishes of like height and unlike evaporating surfaces give the same evaporation if reckoned by depth, but different if by volume; (3) in the case of dishes of different heights, with like or unlike evaporating surfaces, the depth of water lost by evaporation is proportional to the square roots of their heights.

Williams, Samuel.
Experiments on evaporation, and meteorological observations made at Bradford, in New England, in 1772. Trans. Amer. phil. soc., 1786, 2:118–41.

In experiments with evaporation from two small vessels, the amount lost from the one refilled every week was found to be greater than that from the dish which was refilled only once a month. A vessel floated in the Merrimac River during a calm, rainless week lost 0.15 in. by evaporation, while a similar vessel freely exposed in the open air lost 1.50 in. Evaporation was found to be greater from soil covered with vegetation than from an equal area of free water surface.

1787.

de Saint-Lazare, Bertholon.
De l'électricité des meteores. Paris. 1787. 2 v. 8vo.

In volume 2, p. 84–99, a chapter "Sur l'évaporation" proposes an electrical theory for explaining evaporation.

1788.

Cotte, P.
Mémoires sur la météorologie. Paris. 1788. 2 v. 4to.

Discounts (1:100) the influence of moonlight on evaporation. Reviews (1:175–265) experimental and theoretical investigations of various physicists, including Wallerius, Lambert, Musschenbroek, Van Swinden, Richmann, Kratzenstein, Hamberger, Homberg, Desaguliers, Franklin, Kames, Dobson, Achard, etc. Describes experiments as in 1781, to ascertain the influence of the diameter and height of the containing vessels upon the rate of evaporation. Describes (1:280) a simple evaporator used by Chevalier de la Mark. Discusses (1:480) the cooling effect of evaporation as demonstrated with the moistened bulb of a thermometer.

1789.

Saussure, H. B. de.
Col du Géant; expériences sur l'évaporation. Obs. phys., 1789, 34:161–80. Translated in Jour. Phys., Leipsic, 1790, 1:453–73. Reprinted in Voyages dans les Alpes. Geneva, 1779–96. 4 v. 4to.

Evaporation from a piece of moist linen stretched in a frame, was observed on the Col du Géant, where the air pressure is only 18 in. 9 lines, and at Geneva, Switzerland, where it is 27 in. 8 lines, with the result that "other things being equal, a lowering of the pressure of the air by approximately a third makes the quantity of evaporation more than twice as great." Deals also with the cooling effect produced by evaporation.

1790.

Deluc, John Andrew.
Seconde lettre à M. Delamétherie sur la chaleur, la liquefaction, et l'évaporation. Obs. phys., 1790, 36:193–207. Translated in Jour. Phys., Leipsic, 1790, 2:402–29.

Discusses theories to explain the process of evaporation. That of the solution of water by air is considered "a vague hypothesis without solid foundation and useless to explain the phenomenon." He maintains that evaporation proceeds from the union of fire with the molecules of the liquid.

Hube, J. M.
Ueber die Ausdünstung und ihre Wirkungen in der Atmosphäre. Leipsic. 1790. 2 v. in 1. 8vo.

Monge, Gaspard.
Sur la cause des principaux phénomènes de la météorologie. Ann. chim. phys., 1790, 5:1–71.

The vesicular hypothesis of evaporation is rejected in favor of the theory of the solution of water vapor in the air, on the following grounds: (1) Air in absorbing water preserves its transparence, which could not happen if the water was merely suspended by some mechanical means; (2) the solvent power of air diminishes as the quantity of water dissolved increases, so that an actual saturation is reached; (3) the point of saturation varies with the temperature of the air, so that air saturated at a high temperature contains more water than air saturated at a lower temperature; (4) if air saturated with water is cooled it becomes supersaturated and abandons the water which its former higher temperature permitted it to retain. It is concluded that, since these circumstances ordinarily accompany all solutions and are generally regarded as characteristic of them, the absorption of water by air is the result of a true solution.

1791.

Deluc, J[ohn] A[ndrew].
Examen d'un mémoire de M. Monge, sur la cause des principaux phénomènes de la météorologie. Ann. chim. et phys., 1791, 8:73–102. Translated in Jour. Phys. Leipsic, 1792, 6:121–48.

It is maintained that Le Roy's experiments at Montpelier, which Monge (1790) accepted as decisive proof that evaporation is the solution of water in air, are better explained by considering fire as the sole agent.

Vassali-Eandi, A. M.
Esame delle teorie dei principali fenomeni della meteorologica del Sign. Monge, colle riflessione del Sign. ——. Biblioteca oltremontana. Turin. 1791.

1792.

Deluc, John Andrew.
On evaporation. Phil. trans., 1792, 82:400–28. Also in Phil. trans., abridged, 1791–96, 17:259–63. Translated in Jour. Phys. Leipsic, 1794, 8:141–60, 293–302.

The fact that every liquid cools when it evaporates is considered a most decisive reason for the opinion that the dissolution of water, observed in the phenomenon of evaporation, results directly from the action of heat without the intervention of air. Hygrology is defined as the science of the causes of evaporation and the modifications of evaporated water. A discussion of hygrometry follows with the conclusion that the product of evaporation is always an expansible fluid which affects the manometer by pressure and the hygrometer by moisture, without any hitherto perceived influence from the presence or absence of air.

1793.

Dalton, John.

Meteorological observations and essays. London. 1793. p. xvi + 208. 8vo.

The process and circumstances promoting evaporation are described in Pt. 2, Essay 6, p. 132 *et seq.* Heat, dry air, and decreased pressure of the atmosphere upon the evaporating surface are emphasized. In the author's experiments, the rate of evaporation from water, "pretty much exposed to sun and wind," never exceeded 0.2 in. daily. In March the daily average was 0.033 in. It is considered probable that "the evaporation both from land and water, in the temperate and frigid zones, is not equal to the rain that al ls, even in summer."

Wistar, Caspar.

Experiments and observations on evaporation in cold air. Trans. Amer. phil. soc., 1793, 3:125–33.

The author believes these experiments and observations support Deluc's theory, which ascribes the "smoking" of water to the passage of "heat" or "fire" from the moist body into the air around it, a process which does not depend "upon a positive degree of heat, but merely an excess of it in the moist body when compared with the air to which it is exposed."

1794.

Senff, Erdmann Friedrich.

Beobachtungen und Versuche über den Erfolg verschiedener Abdünstungs-Arten des süsses Wassers aus Salz-Soolen auf Salzwerken nebst Folgerungen daraus. (1775, May–Oct.) Jour. Phys. Leipsic, 1794, 8:84–94, 357–66.

Evaporation from water freely exposed from May to October, inclusive, in a small tin vessel amounted to 24 inches, 18/24 line; the rainfall for the same time being 9 inches, 2¼ lines. Experiments made with aqueous salt solutions of different strengths showed that the strongest solutions lost least by evaporation. From a table giving the results of similar experiments under different temperatures, it may be calculated that the ratios between evaporation rates from different solutions approach each other as the temperature increases.

Zylius, J. D. O.

Ueber Herrn Deluc's Lehre von der Verdünstung und dem Regen. Jour. Phys., Leipsic, 1794, 8:51–64.

After discussing the nature of evaporation the author concludes that it is an actual solution of water in air.

1799.

Wistar, Caspar.

Experiments on evaporation. Trans. Amer. phil. soc., 1799, 4:72-3, Also in Med. repos., 1801, 4:179–80.

His conclusions are similar to those in his paper of 1793.

1800.

Heller, Egidius.

Ueber den Einfluss des Sonnenlichts auf die Verdünstung des Wassers. Ann. Phys., 1800, 4:210–22.

Describes observations which tend to show that, the temperature of the air remaining constant, evaporation varies with the amount and strength of sunlight falling on the evaporating surface.

1801.

Dalton, John.

New theory of the constitution of mixed aeriform fluids, and particularly of the atmosphere. Jour. nat. phil. chem., 1801, 5:241–4.

Proposes "four suppositions in respect to the affections of the particles of one elastic fluid toward those of another," and adopts the idea that "particles of one elastic fluid may possess no repulsive (or attractive) power, or be perfectly inelastic with regard to the particles of another; and consequently, the mutual action of such fluids, or the action of the particles of one fluid on those of another, will be subject to the laws of inelastic bodies." Two mixed fluids, "whatever their specific gravity may be, will immediately, or in a short time, be intimately diffused thru each other, in such a manner that the density of each considered abstractedly, will be uniform thruout." The particles "will diffuse themselves thru any given space, occupied by a very rare medium, in the same manner as they would do in a vacuum, each particle being impelled as far as possible from its neighboring particle; only the diffusion of each may be a little retarded by the other." "The vapor of water and of every other fluid which does not unite chemically with the azotic and oxygenous gases of the atmosphere, and without any regard to its pressure on the surface of the earth, being totally uninfluenced by any other pressure than that arising from the weight of their own particles: in short, each vapor, in regard to pressure, is in the same circumstance as if it were the only elastic fluid constituting the atmosphere." "Those gases and vapors press separately on the surface of the earth; and any one of them may be withdrawn or another added to the number, without materially disturbing the rest, or in any way affecting their density. The above doctrine necessarily requires the force of vapor from any fluid to depend solely upon temperature, and consequently to be the same in any gas as in an exhausted receiver."

Hermstaedt, S. F.

Versuche über den Einfluss der Elektricität auf die Verdünstung und meteorologische Folgerungen daraus. Ann. Phys., 1801, 7:501–11.

A mass of air, of known volume at the freezing point, was enclosed over a water seal and heated to 100° (F. ?). The air expanded a certain amount and, upon being recooled to freezing, resumed its original volume. The same air was then subjected to the action of electricity from an electrical machine, cooled, heated, and recooled, as before, when the air appeared to have been permanently expanded. The author concludes that this permanent expansion resulted from the permanent elasticity given to some of the water vapor by the electricity.

Mons, J. B. v.

Censura commentarii a Wieglebo nuper editi, cui titulus: de vaporis aquei in aerem conversione. Brussels. 1801. 4to. Also, Chem. Ann., 1801, 1:76-84, 129-43, 185–200.

Parrott, G. F.

Grundzüge zu einer neuen Theorie der Ausdünstung und des Niederschlags des Wassers in der Atmosphäre. Mag. f. neu Zustand Naturk., 1801, 3:1–57.

An extensive series of experiments, with deductions from his own and others' work, results in an elaborate theory of the phenomenon of evaporation, and of cloud and rain formation. The theory is based on several erroneous conceptions, *e. g.*, that evaporation from ice is oxidation.

Parrott, G. F.

Vermischte physikalische Bemerkungen. Ann. Phys., 1801, 10:166–218.

A distinction is assumed between physical and chemical evaporation; the former is supposed to be dependent on the temperature and the latter on the oxygen content of the air.

1802.

Böckmann, Carl Wilhelm.

Einige Vorläufige Bemerkungen über Herrn Prof. Parrott's neue Theorie der Verdünstung und des Niederschlags des Wassers in der Atmosphäre. Ann. Phys. Leipsic, 1802, 11:66–88.

The author doubts the validity of the experimental evidence furnished by Parrott (1801) and the theoretical conclusions of his paper are controverted.

Dalton, John.

Experimental essays on the constitution of mixed gases; on the force of steam or vapor from water and other liquids in different temperatures, both in a Torricellian vacuum and in air; on evaporation and on the expansion of gases by heat. Mem. lit. phil. soc., 1802, 5:535–602. Translated in Bull. soc. philom., 1803, 3:189–91; also in Ann. Phys., 1803, 12:310–18.

The theory of the chemical solution of water vapor in air is declared to be complex and attended with difficulties, such as that it can exist independently in a vacuum at any temperature. Adopts a theory which admits of a distinct elastic vapor in the atmosphere at all temperatures and uncombined with either of the principal constituent gases. Some general laws of evaporation established by others are exprest.

The objects of the essay are: (1) to determine the effect of temperature on the rate of evaporation; (2) to determine the relative evaporability of different fluids; (3) to find a rule for ascertaining the quantity and effect of water vapor previously in the air; (4) from these and other facts to obtain a true theory of evaporation. A table shows the force of vapor and the full evaporating power of every degree of temperature from 20° to 85° exprest in grains of water raised per minute from a vessel 6 inches in diameter, supposing there were no vapor already in the atmosphere. He determined, by weighing, the amount of water evaporated from two tin dishes, one 6 inches in diameter and ¼ inch deep, the other 8 inches in diameter and ½ inch deep; and found that, for high temperatures, the rate of evaporation was exactly proportional to the vapor tension. To test this principle for low temperatures it was found necessary to consider the partial pressure of the water vapor actually existing in the atmosphere. It is concluded that the evaporating force is equal to the vapor tension at the temperature of the water, diminished by that at the temperature of the air. The same principle was found to hold below the freezing point. He refers to Saussure's experimental determinations of the amount of elasticity imparted to dry air by imbibition of aqueous vapor, and shows that the results coincide rather closely with his own. Dalton, however, considers that Saussure placed too much confidence in his [hair?] hygrometer, and that his observations seem to corroborate the theory that aqueous vapor is a distinct elastic fluid rather than a chemical solution of water in air as he supposed.

Dalton, John.

Experiments and observations made to determine whether the quantity of rain and dew is equal to the quantity of water carried off by rivers, and raised by evaporation; with an inquiry into the origin of springs. Mem. lit. phil. soc., 1802, 5:346–72. Translated in Ann. Phys., 1803, 15:249–78.

The annual rainfall over England and Wales is estimated at 31 inches, and dew-fall at 5 inches, while the runoff of the rivers accounts for only 13 inches, leaving 23 inches to be accounted for by evaporation. An experiment was made with a cylindrical tinned iron vessel, 10 inches in diameter and 3 feet deep, with two tubes inserted in one side and turned downward (for collecting surplus water in bottles), one tube near the bottom, the other an inch from the top. This cylinder was filled with gravel and sand to the depth of a few inches, then with fresh soil, and the whole was sunk in the ground, the side bearing the tubes being exposed. The layer of soil was kept saturated with water. Three years' observations (1796–8) in which the annual average rainfall was found to be 33.55 inches, showed the evaporation from soil to be 25.14 inches, and that from a free water surface, 44.43 inches. Hence, he concluded that: (1) under the above circumstances, 25 inches of the rainfall and the 5 inches estimated for dew, making a total of 30 inches, are evaporated annually; (2) the quantity of evaporation increases with the rainfall, but not proportionally; (3) there is, apparently, no great difference between the amount of evaporation from bare earth with sufficient depth of soil, and that from ground covered with vegetation. The difference between the amount calculated as available for evaporation and the observed amount, is taken to support the theory that the earth derives a supply of water from some subterranean reservoir. Reasons, however, are given for considering the observed evaporation as perhaps greater than the actual, and it is finally concluded that "the rain and dew of this country are equivalent to the quantity of water carried off by evaporation and the rivers."

Dalton, John.

New theory of the constitution of mixed gases elucidated. Phil. mag., 1802, 14:169–73. Also Jour. nat. phil. chem., 1802, 3 (n. s.):267–71. Translated in Ann. Phys., 1803, 12:438–45.

A further explanation of the same theories announced in 1801.

Kirwan, Richard.

Of the variations of the atmosphere. Trans. roy. Irish acad., 1802, 8:278–330.

In the chapter on evaporation, the causes of evaporation are said to be "heat, affinity to atmospheric air, agitation, electricity, and light." Discusses Saussure's experiments with a card supersaturated with moisture, which lost 2 grains in a quarter of an hour when electrified, while another, not electrified, lost 1½ grains. Reprints Saussure's table (1789) comparing evaporation at different altitudes.

1803.

Cotte, L.

Observations météorologiques faites à Montmorenci près Paris pendant l'année 5 (1797) de la République. Mém. inst. nat. sci. et arts, 1803, 4:261–5.

The amount of evaporation for the year 1797 is reported as 18 inches, with a rainfall of 26 inches, 6.8 lines. (Fr. ?.)

Dalton, John.
Eine neue Theorie über die Beschaffenheit gemischter luftförmiger Flüssigkeiten, besonders der atmosphärischen Luft [aus Jour. nat. phil. chem. 5:241]. Ann. Phys., 1803, 15:385–95.

Translation of Dalton, 1801.

Dalton, John.
Versuche über die Expansivkraft der Dämpfe von Wasser und andern Flüssigkeiten, sowohl im luftleeren Räume als in der Luft [aus Mem. lit. phil. soc., 5:550, et seq.]. Ann. Phys., 1803, 15:1–24.

Dalton, John.
Versuche über die Verdünstung [aus Mem. lit. phil. soc., 5:574, et seq.]. Ann. Phys., 1803, 15:121–43.

Dalton, John.
Sur l'expansibilité des gaz mélangés avec les vapeurs, extraite et traduit du Repertory of Arts par Houry. Jour. mines, 1803, 14:33–6.

Gilbert, Ludwig Wilhelm.
Einige Bemerkungen zu Dalton's Untersuchungen über Verdünstung. Ann. Phys., 1803, 15:144–68.

Discusses the theories of evaporation held by Dalton, Saussure, Deluc, etc.

Hermstaedt, S. F.
Observations sur une méthode d'évaporation spontanée de l'eau des puits salins à la température de l'atmosphère; considérations sur le degré d'utilité des applications qu'on pourrait faire dans les salines du Royaume, et recherches sur les causes physiques qui concourrent pour produire cette évaporation. Mém. acad. sci., 1803, (—):91–104. Also Samml. Deut. Abh. Akad., 6:63–73. Also Neu. allg. Jour. Chem., 1804, 2:317–34.

Parrott, G. F.
Ueber Herrn Wrede's Bemerkungen gegen seine hygrologische Theorie. Ann. Phys., 1803, 13:244–50.

Answer to Wrede's criticisms in connection with the theories announced in the papers of 1801. (See Wrede, 1803.)

Parrott, G. F.
Ueber den Phosphor, das Phosphor-Oxygenometer, und einige hygrologische Versuche, in Beziehung auf Herrn Prof. Böckmann's vorläufige Bemerkungen über diese Gegenstände. Ann. Phys., 1803, 13:174–207.

Answer to Böckmann's criticisms of his theories. (See Böckmann, 1802.)

Wrede, E. F. K.
Kritische Bemerkungen über einige neuere Hypothesen in der Hygrologie, besonders über Parrott's Theorie der Ausdünstung und Niederschlagung des Wassers in der atmosphärischen Luft. Ann. Phys., 1803, 12:319–52.

Discussion and criticism of Parrott's (1801) theory of chemical and physical evaporation, Hube's (1790) vesicular system, etc.

1804.

Soldner, Johann von.
Ueber das allgemeine Gesetz für Expansivkraft des Wasserdampfes durch Wärme, nach Dalton's Versuchen; nebst einer Anwendung dieses Gesetzes auf das Verdünsten der Flüssigkeiten. Ann. Phys., 1804, 17:44–81.

A mathematical discussion of the law of increase of vapor tension for every degree of rise in temperature, and the application of this law to the evaporation of liquids. Discusses Dalton's law and develops a formula by which, from the elastic force and the observed evaporation of any liquid at its boiling point, the evaporation at any other temperature may be determined.

1805.

Blanchet, F.
On the vapor which rises from the surface of the River St. Lawrence during the severe cold of winter. Med. repos., 1805, 3:154–5.

Mayer, Johann Tobias.
Lehrbuch über die physische Astronomie, Theorie der Erde und Meteorologie. Göttingen. 1805.

Discusses, p. 168–81, the influence of different temperatures of both the evaporating surface and the surrounding air, on the rate of evaporation; also the influence of sunlight and of different surfaces and depths of the evaporating mass. Defines the atmometer as a glass vessel filled with water, the evaporation from which is measured by a graduated scale or by weighing. For the best results it should be floated on the surface of some large body of water. Discusses the seasonal variations in the amount evaporated.

1807.

Flauguergues, Honoré.
Mémoire sur le rapport de l'évaporation spontanée de l'eau avec la chaleur. Jour. phys., Paris, 1807, 70:446–53. Translated in Jour. nat. phil. chem., 1810, 27:17–24.

Experiments to determine whether evaporation is proportional to the extent of surface exposed, or is dependent on some function of the other dimensions of the body of water, as Musschenbroek and Cotte asserted, proved that it is simply proportional to the surface exposed. Experiments to determine the effect of heat seemed to show that, while the degrees of temperature vary in arithmetical progression, the corresponding losses by evaporation vary in geometrical progression. The following formula shows the relation:

$$y = (4.4) \cdot (2.7182818)^{\frac{x}{11.0527301}},$$

in which x represents the degree of temperature on Deluc's thermometer and y the corresponding evaporation, exprest in parts of the scale used. For the evaporation in millimeters y must be multiplied by $\frac{27.07}{196}$, or we may substitute 0.6268843 for the coefficient 4.4 in the equation.

Soldner, Johann v.
Nachtrag zu der Abhandlung über das allgemeine Gesetz der Expansivkraft der Wasserdämpfe. Ann. Phys., 1807, 25:411–39.

This is a continuation of his paper of 1804, and a discussion of Dalton's law of vapor tension.

1809.

Cotte, Louis.
Mémoire sur l'évaporation. Jour. phys., Paris, 1809, 68:434–41.

1810.

Cotte, Louis.
Mémoire sur l'évaporation. Jour. phys., Paris, 1810, 70:206–8.

D'Aubuisson de Voisan, J. F.
Notice sur la quantité d'eau en vapeur contenue dans l'atmosphère, sur la diminution de densité qui en resulte, et sur le produit de l'évaporation en un temps déterminé. Jour. mines, 1810, 27:411–9.

In discussing the laws of vapor tension and density he derives a formula for the diminution of the density of air due to water vapor. The annual average weight of the vapor contained in a cubic meter of air is given as 9.0 grams, and the annual average diminution of density is 0.0029, the density of air being 1.0. A formula is derived for the quantity of water, Q, evaporated at temperatures between 60° and 100°: $Q = n\phi'$, where ϕ' is the elastic force of vapor at the temperature, and n is a constant to be determined by experiment. Tables show the monthly evaporation calculated for Geneva, that observed at the Observatoire de Paris in 1809, and the evaporation at different elevations as observed by Humboldt, Gay-Lussac, and Saussure.

Fischer, Ernst Gottfried.
Darstellung und Kritik der Verdünstungslehre nach den neuesten besonders den Daltonschen Versuchen. Berlin. 1810. 8vo.

Flauguergues, Honoré.
Mémoire sur le rapport de l'évaporation de l'eau avec l'humidité de l'air. Jour. phys., Paris, 1810, 70:157–67. Translated in Jour. nat. phil. chem., 1812, 32:330–9.

In an experiment to ascertain the influence of humidity on evaporation, air was dried by exposure to lime for three weeks. A vessel was then filled with this air by displacement of sand and it was found that, at a constant temperature, the rate of evaporation from a water surface exposed therein decreased in geometrical progression with the increase in humidity. The author concludes that the rate of evaporation is proportional to the amount of additional water vapor needed for saturation; and points out that this agreement with the law of solution of solids in liquids appears to confirm the hypothesis of Musschenbroek and Le Roy that evaporation of water is merely a solution of this substance in air. Following Saussure, the author determined the absolute humidity of saturated air at 65° F. and announced formulas for finding the point of saturation at any temperature, and for calculating the evaporation at any temperature and humidity. The latter formula is:

$$E = \left[(2.72)^{\frac{x}{11.05}} - \frac{x}{12}\right](0.34 \text{ lines}),$$

where E is the evaporation in lines in 24 hours at the temperature x of De Luc's thermometer, and in air which contains z cubic lines of water in the cubic foot.

1812.

Carradori, Gioachino.
Dell' evaporazione del ghiaccio e della neve. Gior. fis. chim., 1812, 5:203–8.

Upholds the theory of the affinity of air and water, and that evaporation is a combination of molecules of water with "la materia del calorico termico," i. e., the "element" of fire. When water is changed to ice, the affinity of cohesion or aggregation, is changed to chemical affinity or composition. More force is required to evaporate ice than water, because of this chemical affinity.

1813.

Leslie, John.
A short account of experiments and instruments depending on the relations of air to heat and moisture. Edinburgh. 1813. p. 178. 1 pl. (See Brandes, 1823.)

Discusses the cooling produced by evaporation, and the different methods of cooling water, etc., employed by people living in hot countries. Describes a differential thermometer used as a hygrometer, consisting of two glass air chambers connected by a tube containing sulfuric acid (H_2SO_4). His atmometer is a thin ball of porous earthenware, 2 or 3 inches in diameter, with a small neck which is cemented to the lower end of a long and rather wide closed tube, graduated so that each division corresponds to an internal section equal to a film of liquid that would cover the outer surface of the ball to the thickness of 1/1000th part of an inch. In still air the indications of the atmometer and hygrometer were found to have the following relation: 1/20 of a hygrometer degree = 1/1000 inch of evaporation.

1814.

Vassali-Eandi, A. M.
Saggio di un trattato di meteorologia, memoria ricevuta li 19 Dic., 1814. Mem. soc. ital. sci., 17:230–55.

A general account of meteorological instruments which includes a description of an atmidometer (p. 242).

1816.

Bellani, Angelo.
Riflessioni critiche intorna all' evaporazione, colla descrizione di un nuovo atmidmometro. Gior. fis. chim., 1816, 9:102–14, 188–206, 250–62, 417–46. Abstract in Bibl. ital., no. 6, Milan, 1816. Translation of abstract in Bibl. univers., 1816, 2:153–9.

Discussion of work by Leslie and others concerning the cold produced during evaporation. Reviews general laws and theories of evaporation as explained by Saussure, Lavoisier, Cotte, Gay-Lussac, Dalton, Flauguergues, etc. Holds with Kirwan and Richmann that the temperature of the air in contact with the water has considerable influence on the

rate of evaporation. According as the temperature of the air is equal to, warmer than, or colder than the water the evaporation will be slow in the first case, nothing in the second, and rapid in the third. Quotes from ancient writers on the subject.

Thilo, Ludwig.
Über das Verhältniss der Ausdünstung auf dem Meere und auf dem Lande. Arch. Med. Aarau, 1816, 1:250–6.

1818.

Schön.
Die Witterungskunde in ihren Grundlage. Würzburg. 1818.

Discusses methods of measuring evaporation and experiments of Musschenbroek (see Cotte, 1774, and Saussure, 1789).

1820.

Anderson, Adam
Description of a new atmometer. Edinb. phil. jour., 1820, 2:64–7. Translated in Jour. Chem. Phys., 1820, 28:326–8.

Presents objections to the ordinary shallow dish for ascertaining the "dissolving power" of the air, and also to Leslie's porous bulb atmometer. The latter is objectionable on account of the impossibility of using it in frosty weather and during showers, when rain is forced into the interior.

Anderson proposes an instrument which consists of an hermetically sealed system of glass bulbs and tubes containing only alcohol and its vapor, and so arranged that when the two bulbs are at different temperatures the liquid contained in the one bulb will be condensed in a second bulb and collected in a graduated tube attached to the latter. The condensing bulb is covered with wet silk or paper and evaporation therefrom cools the condenser to a temperature below that of the other bulb. The amount of alcohol collected in the graduated tube is a measure of the amount of evaporation during the corresponding time period. The apparatus is inverted to bring the distilled alcohol again into the original bulb. A scale was made for the instrument by comparing its operation with the amount of water lost from a free water surface.

Bellani, Angelo.
Descrizione di un nuovo atmidometro per servire di continuazione e fine alle riflessioni critiche intorno all' evaporazione. Gior. fis. chim., 1820, 3 (decade 2):166–77. Also reprinted, Pavia, 1820.

The evaporating surface of this instrument consists of a porous clay disc which closes the mouth of a metallic vessel connected thru a stop-cock with a second vessel which has a hinged cover. The first vessel is also connected laterally with a horizontal graduated glass tube of small bore having its free end open to the air. The second vessel is so placed that when filled its water level is not higher than that of the clay disc, but is considerably higher than the graduated tube. The whole system having been filled with distilled water and the stop-cock closed, evaporation from the clay surface removes water from the primary vessel and air enters the open end of the glass tube, forcing the meniscus backward at a rate which indicates the rate of evaporation. When the water meniscus approaches the attached end of the glass tube the tube is refilled by opening the stop-cock between the two vessels.

1823.

Brandes, Heinrich Wilhelm.
Uebersetze aus d. Engl. ins Deutsche u. commentirte: Leslie—Kurzer Bericht von Versuche u. Instrumenten, die sich auf d. Verhalten d. Luft zur Wärme u. Feuchtigkeit beziehen. Leipsic. 1823. 8vo.
(See Leslie, 1813.)

Vassali-Eandi, A. M.
Descrizione di un nuovo atmidometro per misurare l'evaporazione dell' acqua, del ghiaccio, e di altri corpe a varie temperature. Ricevuta Aprile 29, 1823. Mem. soc. ital. sci., 1823, 19:347–53.

The author describes a sensitive balance with a thermometer suspended from one end of its beam and dipping into the cup containing the substance whose evaporation is to be studied. He emphasizes the fact that two atmometers to be compared must be exposed under exactly similar conditions.

Vassali-Eandi, A. M.
Nota sopra le straordinarie variazioni del barometro, sopra il massimo grado di caldo e di freddo, la quantitá della pioggia, della neve, e dell' evaporazione, che si osservarrono nel 1821, con alcuni cenni sopra le qualitá dell' annata. Mem. r. accad. Torino, 1823, 27:xli–xliv.

The evaporation for the last nine months of the year 1821 was observed to be 47 inches, 5.3 lines, while the rainfall for the entire year was 36 inches, 11.9 lines.

Walker, Ezekiel.
Philosophical essays selected from the originals printed in the philosophical journals between the years 1802 and 1817. London. 1823. 8vo.

1824.

Daniell, John Frederic.
On evaporation. Quart. jour. sci., 1824, 17:46–61. Also in Notiz. Geb. Nat. u. Heilk., 1825, 10: col. 65–73. See also Boston jour. phil. arts, 1824–5, 2.39–50.

Distinguishes three conditions under which evaporation occurs: (1) When the temperature of the evaporating liquid is such as to produce vapor having a pressure equal to that of the atmosphere, that is, when it boils. (2) When the temperature of the liquid is above that of the surrounding air but below its own boiling point. (3) When the temperature is below that of the atmosphere. Considers (3) at some length. Describes experiments on evaporation from water in almost absolutely dry air (under the bell-jar with sulfuric acid), also under varying pressures (by means of the air-pump). In the latter case there was an increase in evaporation with decrease in pressure, and under yet greater rarefaction the water froze.

1825.

Bostock. John.
On evaporation. (Letter to J. F. Daniell.) Quart. jour. sci., 1825, 18:312–7. See also Notiz. Geb. Nat. u. Heilk., 1825, 10: col. 84–5.

The quantity of water evaporated from a free water surface of small dimensions was determined by weighings at short intervals, accompanied by observations on the temperature of the air and water, barometric readings, direction of the wind, and general weather observations. The tabulated results are followed by some discussion of the relative evaporation at different seasons of the year, under different barometric pressure, different temperatures, etc.

Prinsep, J.
Description of a pluviometer and an evaporometer constructed at Benares. Asiatic researches, 1825, 15: (app.), xiii–xv.

He describes and figures an atmometer consisting of an exposed cup connected with a graduated tube of smaller diameter and at a lower level, this tube being supplied with a piston for driving water into the cup. The instrument is operated by first filling the tube to the standard level and then forcing water by means of the piston, into the cup from which it is in like manner withdrawn to standard level at the end of a given time, note being made of the difference in the position of the piston at the beginning and end of the operation. The ratio between the diameters of the cup and the tube gives the magnification of the observed loss.

1826.

Schübler, Gustav.
Beobachtungen über die Verdünstung des Eises. Naturw. Abh., 1826, 1:211–8. Also general conclusions in Quart. jour. sci., 1829, 1:187.

A table of observations of evaporation from January 1 to February 28 shows the amount lost from a surface of ice or water, the average temperature of the period, the average relative humidity, and the average height of the barometer at 55° F. During certain dry, cold weather the evaporation from ice in twenty-four hours was twice as great as from an equal surface of water in the middle of February during mild, cloudy weather. From these observations it is concluded that "evaporation of ice is far more considerable than has been supposed, and that in certain natural circumstances it may even surpass that of water."

1827.

Hällström, G. G.
De hygrometrico aëris statu tempore aestivo anni 1826 observato Aboa. (Diss. acad.) Aboae. (Abo, Finland), 1827. 4to.

Hällström, G. G.
Observationes circa evaporationem hieme proxime elapsa institutae. (Diss. acad.) Aboae. (Åbo, Finland), 1827. 4to.

Klaproth.
Sur l'évaporation de l'eau à une haute température. Ann. chem. et phys., 1827, 35:325–9.

Experiments with water drops on a very hot metal surface much above the boiling point of water, showed that the hotter the metal the less rapid was evaporation.

Meikle, Henry.
Remarks and experiments relating to hygrometers and evaporation. Edinb. new phil. jour., 1827, 2:22–32.

He presents some experiments and formulas connected with the use of the hygrometer as a measure of evaporation.

Pouillet.
Mémoire sur l'électricité des fluides élastiques, et sur une des causes de l'électricité de l'atmosphère. (Lu à l'acad. des sci., le 30 Mai, 1825.) Ann. chim. et phys., 1827, 35:401–20.

The author describes experiments which show that the electricity accompanying vaporization is due to the more or less intense chemical action which takes place between the elements of the liquid and the vessel which contains it. This fact is considered proof that the electricity of the atmosphere can not have the origin which Volta is said to have assigned to it, i. e., the natural evaporation from land and sea.

1828.

Schrön, Hermann Ludwig Freidrich.
Beschreibung, Gebrauch und Eigenschaften des Hyetometers und Atmometers. Met. Jahrb. Jena, 1828, 6:135–44.

1829.

Experiments on evaporation made in the vicinity of Calcutta. Glen. sci., 1829, 1:286–90.

In connection with the manufacture of salt at Ballyaghat near Calcutta, the rate of evaporation from enclosed tanks of from 150,000 to 850,000 square feet area and 3 to 4.5 inches depth, was studied. The experiments being on such a large scale many sources of error were necessarily considered. After discussing and allowing for these, the conclusion is reached that the evaporation rate for this place is at least as follows: January, 3 inches; February, 5 inches; March, 7 inches; April, 9 inches; and May, 9 inches.

Experiments on evaporation performed at Vera Cruz in 1818–20. Glen. Sci., 1829, 1:335–7.

These experiments on evaporation from water are compared with those near Calcutta, described in the preceding paper. Variations are shown in the amount of evaporation according to the different dishes used and their exposure. To this is subjoined a note giving the results of four years' observations [by the Editor ?] of the evaporation at Benares [Oriental Magazine, 1827, (?)], as follows:

	December and January.	March.	April.	July.
Mean temperature.....degrees F..	62.3	79.4	91.1	84.4
Depression of wet bulb .....do	6	16.3	20.3	2.0
Monthly evaporation.....inches..	2.55	7.3	13.9	3.0

Dalton's formula applied to these figures would give about one and one-eighth times the amount of evaporation actually observed.

1830.

Anderson, Adam.
Evaporation. Edinb. Encyc., 1830, 9:217–21.

The author describes in detail Dalton's experiments on the evaporation from soil and water (Dalton, 1805, 2d title). He cites Duluc, 1792; Dalton, 1802; Saussure, 1783; Murray on Hygrometry in Murray's Chemistry, vol. 2, p. 705; and Doctor Wells on Dew. The latter attempted to show that the ice formed in porous pans at Bombay, is not due to evaporation, but to radiation, that the water, may, in fact, be increased by dew.

Dove, Heinrich Wilhelm.
Notiz über die Verdampfungskälte. Ann. Phys., Leipsic, 1830, 19:356.

The cooling effect produced by evaporation from a thermometer bulb moistened with ether is shown to be accentuated when the ether vapor is absorbed by sulfuric acid as it is formed.

Muncke, G. W.
Geographie nebst Atmosphärologie. Heidelberg. 1830. p. 446–9.

Review of the literature of "atmospherology," including the work of Saussure, Gregory, Musschenbroek, Richmann, Wallerius, Lambert, Cotte, Bellani, and others.

Schübler. Gustav.
Grösse der wässerigen (Ausdünstung) im Jahre 1828. Jour. Chem. Phys., 1830, 58 (J. 28):208–9.

1831.

Holbrook, Josiah.
Evaporation. Scientific Tracts, Boston, 1831, 1:151–4, 257–80.

General discussion of evaporation and the cold produced by the process.

Schübler, G.
Grundsätze der Meteorologie in näherer Beziehung auf Deutschlands Klima. Leipsic. 1831. p. 65–75.

General discussion of the methods of measuring, and the factors influencing the rate of evaporation. A table compares the annual evaporations at Rome, Rochelle, Manchester, Würzburg Tübingen, etc. The effects of temperature and wind on evaporation are also summarized in separate tables. The author then discusses the application of the amount of evaporation to the determination of the dew-point and the moisture content of the air. Studies of evaporation from soil and plants are reviewed and a table shows the relation, at different seasons, of the evaporation from the soil to that from water surfaces. Another table compares the daily evaporation from grass with that from water, and includes average temperatures and wind directions. The grass is seen to have evaporated much more than the free water surface.

1832.

Bellani, Angelo.
Sul moto molecolare dei solidi, e sul limite dell' evaporazione. Poligrafo, 1832, 10:161–70.

Ideler, Iulius Ludovicus.
Meteorologia veterum Græcorum et Romanorum. Berlin. 1832. p. 87–95.

Cites references to evaporation in the writings of Hippocratus, Aristotle, etc. They were apparently aware of the cooling due to evaporation through porous vessels containing water, etc.

1836.

Bischof, K. G. C.
Einige physikalische und chemische Beobachtungen in den Schweizer Alpen.—1. Ueber die Verdünstungskälte in der Nähe von Wasserfällen. Ann. Phys. and Chem., 1836, 37:259–61.

Observations of temperature in the immediate neighborhood of waterfalls and at some distance from them show the cooling effect produced on the surrounding air by the evaporation of the mist.

Kämtz, Ludwig Friedrich.
Lehrbuch der Meteorologie. Leipsic. 1836. p. 344.

Gives a general discussion of the subject.

Murphy, Patrick.
Meteorology. London. 1836. p. 82–91.

Ridicules the theory of the solution of water vapor in air, upholding that evaporation is an electrical decomposition of water into oxygen and hydrogen. Quotes Bertholon de Saint-Lazare (1787) at some length in support of this view.

1837.

Howard, Luke.
Seven lectures on Meteorology. Pontefract, England. 1837. p. 69–72.

Describes the process of evaporation and concludes that, on the whole, the amount evaporated must be equal to the rainfall, "the one being the source of the other." Affirms the rate of evaporation to be dependent on temperature and wind velocity and states that a common rate per day from a freely exposed water surface is 1/100 to 1/10 inch in winter, 2/10 to 3/10 inch in summer. A table of the monthly evaporation near London from 1807 to 1815, shows an average total for the year of 30.75 inches.

He considers that the best instrument for measuring evaporation is a "shallow, metallic cistern" provided with a scale of three diagonals, engraved on an oblong plate of glass, the divisions of the scale to be 1/10 inch apart, and the descent in proportion of 1/100th to each division.

Klee, Franz.
Prüfung der Lehre von Druck der Luft, nebst einer neuen Theorie über die Verdünstung und Bildung der Niederschläge in der Atmosphäre. Mainz. 1837. 8vo.

Pouillet.
Éléments de physique expérimentale et de météorologie. Paris. 1837. 2 vols. 8vo. See 1:261, 291, 303–6, 555 et seq.; and 2:629–30.

Pouillet supports a theory of evaporation agreeing in the main with that of Dalton, [Dalton, 1801 and 1802, 1st title]. The rate of evaporation depends, not only on the movement of the air, but on the difference between the pressure of the vapor forming and that of the vapor already formed in the air. He quotes Dalton's law. Evaporation is also proportional to the extent of surface exposed. In discussing the cold produced by evaporation, the author states that 1 grain of water vapor, formed by evaporation, has absorbed a quantity of latent heat capable of raising 500 grains of water 1° in temperature. In volume 2 it is maintained that atmospheric electricity results from the chemical segregations accompanying evaporation from the surface of the earth.

1838.

Espy, J. P.
Experiments on spontaneous evaporation. Franklin inst. jour., 1838, 22:74–5.

He describes simple experiments with evaporation of water from porous pots and tumblers sunk in the ground, from moist earth, and from wet towels in motion and at rest; and gives the accompanying temperatures of the air and the dew-point.

Leslie, J.
Treatises on various subjeces of natural and chemical philosophy. Encyclopedia Britannica. Edinburgh. 1838.

In the chapter on Meteorology, p. 402–537, the porous clay atmometer is described as in his paper of 1813. A general review of the theoretical side of the subject includes the vesicular theory held by Halley, Leibnitz, Musschenbroek, Desaguliers, Kratzenstein; and the advance made in 1750 by Hamberger, who attributed evaporation to a real solution of moisture in the air, and by Le Roy who followed along the same lines. The experiments of Wallerius, Musschenbroek, Richmann, Saussure, and Kirwan are given critical attention. It is maintained that the full cooling effect on the wet-bulb thermometer may be obtained without the whirling practised by Saussure.

1840.

Kämtz, Ludwig Friedrich.
Vorlesungen über Meteorologie. Halle, 1840. p. 69, 392.

A general discussion.

Muncke, G. W.
Verdünstung. Gehler's Physikalisches Wörterbuch. Leipsic. 1840. 9 (pt. 3):1720–50.

The article Verdünstung gives a survey of the literature of the subject up to 1840, including the work of Dalton, Schübler, and others.

1842.

Dausse.
De la pluie et de l'influence des forêts sur les cours d'eau. Ann. ponts chauss., 1842, 3 (2): 184–209, 197–201.

In discussing the effects of evaporation and its immense rôle in nature, the author presents tables of rainfall and evaporation in France, together with the average monthly height of the Seine. The object is to show that the greatest evaporation follows close upon the greatest rainfall, but that the highest stage of the Seine occurs when the rainfall and evaporation are least. It is calculated that evaporation reduced the volume of water in the Seine from 7 to 3, or more than half, and that the reduction would not have been as great if the banks had been forested instead of being bare as was the case at that time.

Rowell, G. A.
On the retardation of evaporation by electric insulation. Proc. Ashmol. soc., 1841, 23:7. Also Phil. mag., 1842, 20:45–6.

Experiments on the relative evaporation of water from an insulated vessel and an uninsulated one, showed an excess of evaporation from the latter of 14 dwts., 9 grains. The author belives that if complete insulation could be maintained, no evaporation would take place at moderate temperatures.

Saigey.
Petite physique du globe. Paris. 1842. p. 108–12.

The yearly evaporation at Paris from circular dishes, 30 or 60 centimeters in diameter, and 10 or 20 centimeters deep, is stated to be about 800 mm. when the dishes are half filled with water.

1844.

Baily, J.
On the Isthmus between the Lake of Grenada and the Pacific. Jour. roy. geog. soc., 1844, 14:127–9.

An incidental remark in this article states that, according to various calculations, the average annual evaporation in inter-tropical climates amounts to 39 inches.

Liénard.
Sur le mélange de l'eau de mer à l'atmosphère. Mém. soc. agr., Bayeux, 1844, 2:289–90.

1845.

Daniell, John Frederic.
Elements of Meteorology. London. 1845. 2 v. Volume 2, p. 25, 66, 220, 236.

According to this author, "the hygrometer may be applied to indicate the force and quantity of evaporation." Refers to Dalton's law that the quantity of water evaporated in a given time, bears a definite relation to the force of vapor at the same temperature. A table shows the full evaporating force of every degree of temperature from 18° to 85° F. Discusses the conditions and laws of evaporation from water and soil.

Laidlay, T. W.
Observations on the rate of evaporation on the open sea; with a description of an instrument used for indicating its amount. Jour. Asiat. soc. Bengal, 1845, 14:213–6. Also abstracted by Blanford, 1877.

Leslie's atmometer is described and criticized as lacking simplicity of construction and use. An instrument of his own invention consists of a small glass tube, closed at both ends, at the lower end by means of a plug of some porous substance as wood. The tube is filled with distilled water and attached to a scale upon which the amount lost from the tube by evaporation from the surface of the plug may be observed. Observations were made with this instrument, hung in the shade but freely exposed to the wind, on board ship between England and Calcutta. The daily average,, from lat. 37° 15′ S. to lat. 24° 25′ S., was 0.398 inches, and thru the Tropics 0.809 inches. A table of von Humboldt's results of observations in similar regions with Deluc's hair hygrometer, reduced by d'Aubuisson's formula, gives a much smaller rate. Laidlay explains the discrepancies by the fact that Deluc's hygrometer takes no account of the important agency of the wind. Laidlay's instrument, suspended in the shade on an open verandah in Calcutta, gave a daily average evaporation of 0.507 inches for the year.

Parkes, Josiah.
On the quantity of rain compared with the quantity of water evaporated from or filtered thru soil; with some remarks on drainage. Jour. roy. agr. soc., 1845, 5 (1st ser.): 146–58.

The author describes experiments by John Dickinson, to determine the percentages of rainfall which percolate thru the soil or evaporate from its surface. Besides a rain gage, he employed for this purpose a cylinder filled with soil and sunk in the ground, this cylinder having a false perforated bottom and a receptacle beneath for collecting the percolation water. This lower receptacle communicated by a small tube with a second vertical cylinder

below the level of the other, the diameter of the second bearing some convenient ratio ot that of the first. The percolation water is measured by means of a graduated stem borne on a float in the second cylinder. The evaporation includes that due to the plant growth on the surface of the soil. The results of eight years' observations, 1836–43, show the annual evaporation to be 57.5 per cent of the rainfall, or 15.3 inches. Other estimates are quoted.

Regnault, Victor.

Etudes sur l'hygrométrie. Compt. rend., 1845, **20**:1127–66, 1220–37. Also Ann. chim. et phys., 1845, **15** (3d ser.):129–236. Translated from Comptes rendus in Ann. Phys. und Chem., 1845, **65**:135–58, 321–60. Also Sci. mem., 1846, **4**:606–60.

The first part (p. 1128–66) contains: (1) a table of the varying tensions of water vapor in saturated air at a series of different temperatures; (2) a table of the varying densities of water vapor in saturated air at different temperatures; (3) a table of similar densities in air of different degrees of humidity below saturation. The second part (p. 1220–37) describes methods of determining the relative humidity of the air: (1) the chemical method; (2) that founded on the changes occurring in hygroscopic materials; (3) that of the condensation hygrometer; (4) that founded on the indications of the wet and dry-bulb thermometers. This is followed by formulas and tables.

Rowell, G. A.

On the phenomena of evaporation, the formation and suspension of clouds, etc. Edinb. new phil. jour., 1845, **38**:50–6. Reviewed in Franklin inst. jour., 1847, **44**:340–3.

The author is of the opinion that vaporization is produced by an increase in the electrical charge of the water particles and that condensation is due to a decrease in or removal of this charge. Thus evaporation is considered a phenomenon of static electricity. This theory is elaborated at length and a number of meteorological phenomena are considered from this standpoint.

1846.

Ludlow.

Observations on evaporation made at the Red Hills, near Madras, in 1844. Madras jour. lit. sci., 1846, **13**:87–93. Also quoted by Blanford, 1877.

By careful experiments he compared the rate of evaporation from an evaporator floated on the surface of a large tank, with that from an evaporator on land some distance from the tank, and found one-fifth less evaporation from the tank exposure than from the land exposure during the hottest months of the year. The results show a gradual increase in the ratio between the two, but this is at least partially accounted for by the fact that the depth of the water in the tank diminished about 6 feet from April 1 to August 20. He concludes that "depth is important in such reservoirs, the amount of evaporation not only increasing with surface but inversely as the depth." The rainfall during the period was 8 inches, the total fall in the water level of the tank was 33 inches, and the evaporation 53 inches, so that only three-eighths of the amount disappearing was available for irrigation. Tables of results, including temperature observations, etc., are given.

1847.

Daubrée, G. A.

Observations sur la quantité de chaleur annuellement employée à évaporer de l'eau à la surface du globe, et sur la puissance dynamique des eaux courantes des continents. Abstract by the author, Compt. rend., 1847, **24**:534–50. German translation in Ann. Phys. und Chem., 1847, **71** (3d ser.):173–5.

In calculating the amount of heat annually consumed in evaporation, the total evaporation is considered equal to the total rainfall on the surface of the earth, which is estimated as 703,435 cubic kilometers, equivalent to a layer of water having a uniform depth of 1.379 meters over the entire earth. This amount of evaporation consumes nearly one-third of the heat annually received from the sun. The total energy of evaporation is estimated as more than 1,800 times that manifested by the flowing waters of the earth, the latter approximating 9,000 million horse-power.

Glaisher, James.

Hygrometrical tables, containing temperature of the dew-point; the elastic force and weight of vapor; degree of humidity; weight of air, etc.; corresponding to all readings of the dry- and wet-bulb thermometers between 10° and 90° [F.]. With directions for using, and explanation of the theory and uses of the dry- and wet-bulb thermometers. London. 1847. First edition. 8vo.

Babinet, J.

Note sur un atmidoscope. Compt. rend., 1848, **27**:529–30.

He describes an instrument somewhat similar to Leslie's (1813), in which evaporation takes place from the surface of a reservoir of porous clay filled with water. The reservoir is supplied from a vertical tube connected therewith and at a lower level, and the evaporation is measured by the lowering of the water level in the latter. The advantage is claimed for this instrument over the ordinary hygrometer, of being influenced by the movement of the air and of registering the integrated effect from the beginning of the experiment.

Cartillon, C.

Synthèse de quelques météores dépendents du phénomène de l'évaporation de l'eau. Trans. Roy. soc. arts, sci., Mauritius, 1848, **2**:97–118.

Rowell, G. A.

On the cause of evaporation, rain, hail-stones, and the winds of the temperate regions. Rpt. Brit. assoc. adv. sci., 1847. (Notices p. 41.)

Repeats his hypothesis expounded in 1845.

1848.

Vallés, F.

Projet de desséchement et d'irrigation du lac de Grand-Lieu. Ann. ponts chauss., 1848, **16**:158–251.

Dissusses, p. 226–31, the relative intensity of evaporation. Results obtained from 1782–1801 by Calandrelli and Conti are quoted from de Prouy's work on the Pontine marshes (?). A table gives the annual average evaporation as 2.362 meters and the ratios according to the seasons. The daily evaporation at Nantes is calculated at 0.005 meters.

1849.

Buist, G.

On the saltness of the Red Sea. Trans. Bombay geog. soc., 1849, **9**:38–48.

It is stated incidentally (p. 39), that the temperature of the surface of the Red Sea varies from 65° to 85° F., that the difference between the wet-bulb and dry-bulb is from 25° to 40° F., and that the average evaporation at Aden is 8 feet per year.

Charnock, J. H.

On suiting the depth of drainage to the circumstances of the soil. Jour. roy. agr. soc., 1849, **10**:507–19.

In connection with percolation experiments, from 1842 to 1846 inclusive, the following average annual data are presented in tabular form: (1) rainfall, 24.6 inches; (2) evaporation from a water surface freely exposed to sun and wind, 35.05 inches; (3) evaporation from water shaded from sun but exposed to wind, 23.35 inches; (4) evaporation from drained soil, 19.76 inches; (5) evaporation from saturated soil, 32.68 inches. Dalton's observations (1802, 2d title) in similar experiments are quoted, together with those of Dickinson (Parkes, 1845).

Harting, Pieter.

Drie nieuwe physische wertingen-Hygrometer, Drijfbalans, en Atmometer of Verdampingsmeter. Utr. Anteek. prov. genoots., 1849, (—):6–18.

Norton, W. A.

On the diurnal variations in the declination of the magnetic needle, and in the intensities of the horizontal and vertical magnetic forces. Amer. jour. sci., 1849, **8**;350–64. Abstracted by Ramsay, 1884.

He attributes the daily decrease in the horizontal force of the magnetic needle, between 4 and 10 a. m., to the evaporation of the dew or rain that has fallen during the night.

Schübler, G.

Grundsätze der Meteorologie in näherer Beziehung auf Deutschlands Klima. Leipsic. 1831. First Edition. Neu Bearbeitet [2d Edition] von G. A. Jahn. Leipsic. 1849.

Evaporation is discust on p. 72–80.

1850.

Kunzek, August.

Lehrbuch der Meterologie. Vienna. 1850.

Gives definitions of Verdünstung and Verdampfung (p. 95), and discussion of evaporation in general (p. 96).

Lenz, H. F. E.

Beitrag zur Bestimmung der in St. Petersburg verdünstenden Wassermenge, Mél. phys. et chim., 1850, **1**:226–38. Also Bul. acad. imp. sci., 1851, **9**:col. 86–94.

The loss of weight by evaporation from two small brass dishes of water, was observed during the winter of 1849–50. The apparent disagreements between the evaporation rate on the one hand, and the temperature and humidity on the other, are explained by wind conditions, the importance of which as a factor influencing evaporation is emphasized. Comparisons of the evaporation from ice with that from freezing water, show the latter to have the higher rate. A curve of bi-hourly readings of evaporation is seen to follow the daily march of temperature. He also compares the diurnal and nocturnal rates of evaporation

Vallés, F.

Note sur une exception remarquable que présente la mesure de l'évaporation naturelle à Saint-Jeane-de-Losne, Dijon, Pouilly et La Roche-sur-Yonne. Ann. ponts chauss., 1850, **20**:383–93. Abstract in Rogers Field, 1869.

According to this paper hydraulic engineers have generally considered the amount of evaporation in France to be much greater than the rainfall. Seven years' observations on the Canal de Bourgogne at the places mentioned show, however, that only once did the evaporation exceed the rainfall, and that the average evaporation is less than half what it had hitherto been considered. (See Tarbé, 1852, for similar results.)

1851.

Charié-Marsaines.

Sur les travaux de la rigole dérivée de l'Yonne pour l'alimentation du point de partage du canal du Nivernais. Ann. ponts chauss., 1851, 1 (3d. ser.):289–333.

In Note A, p. 320–4, are described observations on evaporation from the Languedoc canal for the 320 days that the navigation of the canal annually lasts, and the result showed a loss of 0.812 meter. The results obtained by Halley, Sedileau, and Cotte are quoted, and the ratio between the evaporation at different seasons of the year, as estimated by Vallés and Cotte, is discust.

Espy, James.

Third Report on Meteorology to the Secretary of the Navy. Washington, 1851.

He reports, p. 19, experiments on the relative lowering of temperature produced by the evaporation of sea water and fresh water from the bulb of a thermometer. An equal depression was thought to have been observed in both cases, wherefore it is assumed that evaporation from sea water is the same as evaporation from fresh water under the same circumstances.

Miller, J. F.

On the relation of the air and evaporation temperatures to the temperature of the dew-point, as determined by Mr. Glaisher's hygrometrical tables founded on the factors deduced from six-hourly observations made at the Royal Observatory, Greenwich. Phil. trans., 1851,(—):141–8. Notice in Phil. Mag., 1 (4): 168.

A comparison of dew-points determined by the use of Daniell's hygrometer and the wet- and dry-bulb thermometers proved the extreme accuracy of Glaisher's tables. Experiments on the evaporation of water in a small copper vessel exposed to sun and wind, but partially sheltered at night and in wet weather, showed an annual average for the six years, 1843–8, of 30.011 inches with an average annual rainfall of 45.25 inches.